NSWC Carderock & Department of Energy Host Wave Energy Competition

Aquaharmonics Claims $1.5 Million Prize for Winning Prototype

THE DEPARTMENT OF Energy's (DOE) Office of Energy Efficiency and Renewable Energy announced AquaHarmonics as the first-place winner at the Wave Energy Prize Innovation Showcase held at Naval Surface Warfare Center (NSWC), Carderock Division in West Bethesda, MD on November 16, 2016.

Nine teams competed as finalists in the competition, which was hosted by the DOE and supported by both the Office of Naval Research and NSWC Carderock. The purpose of the contest was to test various wave energy conversion (WEC) prototypes and evaluate their effectiveness for harnessing energy from ocean waves, with the ultimate objective of identifying an effective model for future, larger scale wave energy devices. The competition aimed to double the energy typically generated from ocean waves and identify a cost-effective solution for wave energy on par with conventional energy sources.

The ceremony to recognize the winners and runners-up was attended by Dr. Franklin Orr, Department of Energy Under Secretary for Science and Energy; Dennis McGinn, then-Assistant Secretary of the Navy (Energy, Installations & Environment); Joseph Bryan, then-Deputy Assistant Secretary of the Navy for Energy; Capt. Mark Vandroff, NSWC Carderock Commanding Officer; and David Masten, founder, chairman and chief technology officer of Masten Space Systems.

"If you look around, it doesn't take long to go to the beach and see, 'Wow, that's a lot of energy,'" said McGinn during remarks at the showcase. "So figuring out how we can harvest that energy in an inexpensive, reliable way makes so much sense. It will add to our energy portfolio ... having this added to it, along with wind and solar [power], just makes a lot of sense."

DOE's Marine and Hydrokinetic Technology Program Manager Alison LaBonte explained the inception of the competition. In recent years, DOE has routinely received wave energy proposals from various companies and institutions, but recognized that many newer and smaller organizations have a limited understanding of how to get their projects funded.

"What we didn't have was a mechanism for those players out there that may not have experience trying to receive government grants, or even where to apply for government grants that they could easily—with no hurdles of bureaucracy—bring these ideas to the table and have them evaluated," said LaBonte. "We wanted to attract those new players, create a level playing field for them all. We're still young enough in the technology development that we could discover

2016 Wave Energy Prize Winners

First Place	AquaHarmonics (Portland, OR)	$1.5 million
Second Place	CalWave Power Technologies (Berkeley, CA)	$500,000
Third Place	Waveswing America (Sacramento, CA)	$250,000

something that's far out, while in position to succeed in our long-term goal of cost-competitive energy conversion in high energy/low cost market."

Ninety-two teams originally registered for the competition in April 2015. During the 20-month duration of the competition, teams designed, built and tested their devices. The three-phase competition was divided into four distinct technology gates:

- Technology Gate 1: Technical submission; for determination of qualified teams (Prize Phase 1: Design)
- Technology Gate 2: Small scale (1/50th) model testing, numerical modeling for determination of finalists and alternates (Prize Phase 1: Design)
- Technology Gate 3: Verify the level of build progress and test readiness of identified finalists and alternates (Prize Phase 2: Build)
- Technology Gate 4: Testing of 1/20th scale model at the maneuvering and seakeeping (MASK) basin at NSWC Carderock; for determination of prize winners (Prize Phase 3: Test and Evaluation)

The field of competitors narrowed as each technology gate was reached. Sixty-six teams met the conditions to pass technology gate 1. Wave Energy Prize judges then selected

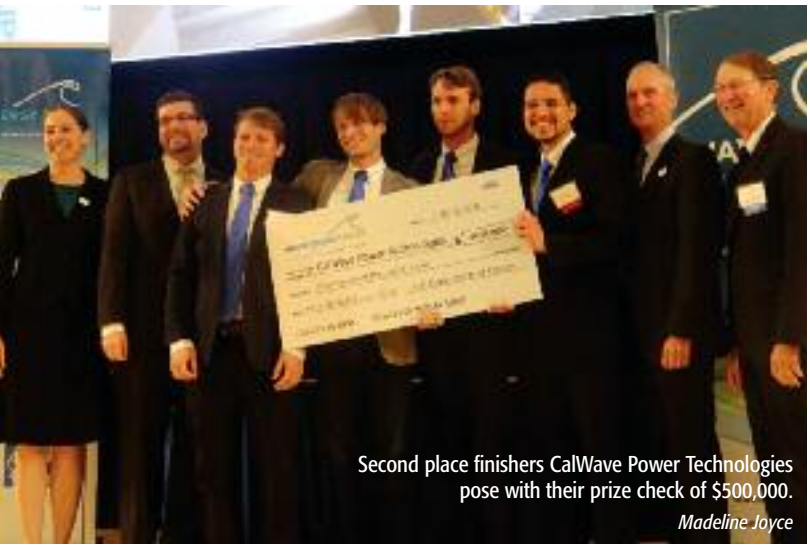
Then-Assistant Secretary of the Navy (Energy, Installations & Environment), Dennis McGinn gives opening remarks at NSWC Carderock's Wave Energy Prize Innovation Showcase.

AquaHarmonics displays their trophy and a scale model of their wave energy device at the Wave Energy Prize Innovation Showcase at NSWC Carderock on November 16, 2016.

Madeline Joyce

Alex Hagmuller and Max Levites-Ginsburg of Aquaharmonics pose with Alison LaBonte (far left) and other competition organizers to accept their first-place prize of $1.5 million at NSWC Carderock's Wave Energy Prize Innovation Showcase.
Madeline Joyce

> We were working out of a garage, we didn't have a lot of resources, [and] we didn't have great facilities... it was surprising to us what we were able to achieve.
>
> *–Max Levites-Ginsburg*



Second place finishers CalWave Power Technologies pose with their prize check of $500,000.
Madeline Joyce

Third place finishers Waveswing America pose with their prize check of $250,000.
Madeline Joyce

20 teams to proceed to technology gate 2, which were further narrowed to nine finalists and two alternates that competed in technology gate 3. Technology gate 4 commenced in August 2016, where the nine selected finalists tested their 1/20th scale models.

NSWC Carderock served as an ideal venue for the competition due to the location of the MASK basin. The 12-million-gallon facility is the Navy's largest wave pool and is capable of mimicking various ocean conditions. Supporting wave energy testing also meets Carderock's congressional charter, which directs that the command sustain both Navy operations and requirements for the overall maritime industry.

"I already knew that Carderock had technical expertise that could be leveraged for wave energy technology device testing," said LaBonte. "They also bring to the table the human element of what it means to hold a high-profile competition on your grounds, and the value that provides for attracting a workforce to the science and engineering domain. Combined with a real appreciation of the energy security challenges facing the Navy, Carderock was uniquely qualified to bring all of this together in one place."

Staff at Carderock contributed to writing rules with the prize administration team and were instrumental during the testing phase of the competition. David Newborn, ocean engineer at Carderock's Maritime Systems Hydromechanics Branch, served as one of the five judges on the panel. He spoke of why this competition was advantageous to Navy operations. "A significant amount of our assets are shore based…so our facilities may be able to utilize some of that [wave] power." Researchers are also

The Innovation Showcase demonstrated AquaHarmonics' WEC device at NSWC Carderock's MASK basin.
Madeline Joyce

exploring the feasibility of leveraging this same technology on afloat platforms.

Remote island regions where it is costly to transport fuel would benefit from wave energy technology. "Typically in places that are surrounded by the ocean and that have a really good wave resource are places where it is very expensive to get fuel. So it becomes economically viable in regions where access to fuel is expensive such as Hawaii, Diego Garcia and Guam," said Newborn.

The two-person team of AquaHarmonics of Portland, OR is comprised of Alex Hagmuller and Max Levites-Ginsburg, civilian engineers and Oregon State University graduates. Hagmuller and Levites-Ginsburg's first wave energy model dates back to 2009 and spawned several more prototypes before they settled on their winning design. The simple design consists of a steel buoy, situated in a sealed ball attached to a motor anchored to the seafloor. Hagmuller explains its process, "On the upswell of the wave you're able to generate power and on the downfall of the wave, the generator actually acts as a motor and reels the line back in and gets ready for the next wave set."

Hagmuller believes the design model and capability makes it a viable device. "Any type of remote type operation that's in a maritime environment offshore…you name it, it can be integrated into that," he concluded.

"We were working out of a garage, we didn't have a lot of resources, [and] we didn't have great facilities … it was surprising to us what we were able to achieve," Levites-Ginsburg stated at the Innovation Showcase.

What they achieved was a powerful device that quintupled the baseline energy production requirement previously established. AquaHarmonics demonstrated their

Department of the Navy's Exploration of Wave Energy

THE NAVY ESTABLISHED a Wave Energy Test Site (WETS) off the coast of Kaneohe, Hawaii as a test site in coordination with the Marine Corps, private sector developers, Department of Energy and the Hawaii Natural Energy Institute. The Azura WEC device located at WETS is generating electricity for the island of Oahu and Marine Corps Base Hawaii, capable of generating up to 18 kilowatts of electricity. The state of Hawaii's goal is to be powered 100 percent on renewable energy by 2045, and the WEC is one of the sources contributing to that objective. In July 2016, the Naval Facilities Engineering Command Engineering and Expeditionary Warfare Center hosted a blessing ceremony to commemorate the addition of deep-water berths at WETS that comprise the grid infrastructure along with shallow-water berths.

Alex Hagmuller, a mechanical engineer from the AquaHarmonics team, tells the crowd how their WEC device is working to absorb energy from waves, which can then be converted and used as a power source before the demonstration of the device.
Monica McCoy

winning device at the innovation showcase where the prototype extracted energy from the waves created in the MASK basin for the audience.

Second place finisher CalWavePower Technologies of Berkeley, CA, comprised of a four-person engineering team, submitted a submerged differential device into the competition. In third place, the three-person team of WaveSwing America of Sacramento, CA showcased their sub-sea pressure-differential point absorber wave power generators.

Ms. LaBonte highlighted the collaboration between the Navy and DOE. "We learned a lot from each other through the course of the competition. Now we've basically spun off a list of what things could we collaborate on moving forward, now understanding what we know about each other's challenges. So it's been really valuable," she said.

LaBonte believes wave energy has strong potential for making facilities more resilient.

"Could this technology be one that's possible to install, operate and maintain for increasing our energy security at our bases, at our installations?" LaBonte posed. "I think we both have a better understanding that the answer is yes, and the timeline is still a little down the road. But feasible solutions have already been brought to the table."

NSWC Carderock is a field activity of Naval Sea Systems Command and headquartered in West Bethesda, MD. Their mission is to provide research, development, test and evaluation, analysis, acquisition support, in-service engineering, logistics and integration of surface and undersea vehicles and associated systems. Comprised of approximately 3,200 scientists, engineers and support personnel, they are the Navy's experts in maritime technology. ⚓

NSWC Carderock's Maneuvering and Seakeeping Basin

NSWC CARDEROCK'S MASK basin is the Navy's largest indoor wave pool. The Navy constructed the wave pool in 1962 to evaluate the maneuverability of scale models of ships and other platforms under realistic sea conditions. With dimensions of 360-feet long by 240-feet wide, the pool holds approximately 12 million gallons of water. Carderock renovated the pool in 2013, installing 216 individually controlled electromechanical wave boards to simulate the ocean environment. The MASK basin can test ship models up to 30 feet in length to evaluate their performance and durability in harsh maritime environments.

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